Map-Constrained Visual Mapping

Accurate and drift-free environment reconstruction is a core requirement for autonomous systems, robotics, and geospatial applications. Traditional visual SLAM systems rely solely on sensor data to incrementally build a map, but over time this leads to accumulated drift and misalignment — especially in large-scale or repetitive environments. Recent advances, such as *OpenLiDARMap*, demonstrate that integrating prior knowledge in the form of sparse digital maps can substantially increase global consistency in LiDAR-based mapping.

This thesis will explore how to extend this concept to purely camera-based pipelines. The objective is to develop a SLAM system that fuses state-of-the-art visual reconstruction techniques such as including Structure from Motion (SfM), Gaussian Splatting-based scene representations, or monocular depth estimation, with constraints derived from existing digital surface models and building models.

The central idea is to correct and regularize the visual mapping process using known, albeit sparse and sometimes imperfect, geospatial priors. This approach aims to reduce local drift, resolve global alignment ambiguities, and enable highly consistent 3D reconstructions even in challenging visual conditions. The system will be evaluated for its ability to maintain both local geometric accuracy and long-term global consistency.

The thesis will include:

- A review and comparison of modern visual reconstruction pipelines (SfM, Gaussian Splatting, monocular depth)
- Integration of digital surface and building models as global priors into the mapping loop
- Development of alignment and correction techniques to constrain visual SLAM with map data

What you have to bring:

- Experience with Python, C++ and Docker
- Experience with SLAM approaches
- Experience with optimization frameworks (GTSAM, Ceres ,..)
- Fluent in English or German
- Interest in robotics and autonomous navigation

Contact:
If you are interested in this project or have your own ideas on this topic, send your CV and transcript of records with a few sentences about your motivation or idea to:

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